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A PLIOCENE FLORA FROM THE EDEN BEDS

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A small collection of well-preserved leaves and seeds from the Eden beds of Riverside County, California, includes elements of the living endemic flora of central and southern California whose occurrence has been scanty or absent in the fossil record. This material was collected near Beaumont by Guy Hazen, and has been sent by Childs Frick to the University of California for study.

The fossil locality is situated about two miles south of Beaumont in a lower portion of the Eden beds, the plant-bearing deposits extending over an area of about two miles.

The sandstones and shales of the Eden formation, originally described by Frick[2] and as more recently observed by Fraser,[3] consist of two members:

(1) The Eden beds proper, which have the same dip and strike as the underlying red beds, and an approximate thickness of 1,500 feet. Minor faults are responsible for the chief disturbance of the Eden member, as it is located between two major fault zones.

(2) The underlying red beds, which are about 1,800 feet thick and were deposited by streams flowing from igneous and metamorphic areas into an arid, flatter country which acted as a basin of deposition. These red beds strike northwest with a low to moderate dip, and exhibit a number of breaks and small faults.

In general the red beds have greater continuity and are broken and displaced to a smaller extent than the overlying Eden beds, indicating that the movements must have been chiefly post-Eden. The greater disturbance of the overlying Eden beds is due to their general lack of induration and tendency to slump. Following the Eden deposition on the red beds, the area was faulted and uplifted with northward tilting, accompanied and followed by erosion. The Eden beds proper, according to Frick,[4] of the Uppermost division of the Pliocene, afford the best-known representation of a mammalian fauna of the American Uppermost Pliocene.

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[1]University of California.

[2]Frick, C. 1921. 'Extinct Vertebrate Faunas of the Badlands of Bautista Creek and San Timoteo Cañon, Southern California.' Univ. Cal. Pub., Bull. Dept. Geol. Sci., XII, No. 5, pp. 283–288 and 339, top, "The red phase."

[3]Fraser, D. M. 1931. 'Geology of San Jacinto Quadrangle South of San Gorgonio Pass, California.' State Cal. Div. Mines, XXVII, No. 4, pp. 511–516.

[4]Frick, C. 1933. 'New Remains of Trilophodont-Tetrabelodont Mastodons.' Bull. Amer. Mus. Nat. Hist., LIX, Art. IX, p. 516 (faunal list).

Following is the list of thirteen genera recognized. Six forms are referred to fossil species previously recorded from the Pliocene[1]; the remainder are not represented in the collection by sufficient material to warrant their description as new species, and their close resemblance to modern species is indicated. Nine species are represented by leaves, three by seeds and three by cones containing seeds. Several wood fragments, leaves and seeds have not yet been identified.

PRELIMINARY LIST OF FOSSIL SPECIES AND THEIR MODERN EQUIVALENTS

FOSSIL SPECIES	MODERN EQUIVALENTS
Arctostaphylos sp.	*Arctostaphylos* sp.
Ceanothus sp.	*Ceanothus cuneatus* (Hooker) Nuttall
Cercocarpus cuneatus Dorf	*Cercocarpus betuloides* Nuttall
Gramineae sp.	*Gramineae* sp.
Juglans sp.	*Juglans californica* S. Watson
Pinus sp.	*Pinus coulteri* Don
Pinus pieperi Dorf	*Pinus sabiniana* Douglas
Platanus paucidentata Dorf	*Platanus racemosa* Nuttall
Platanus sp.	*Platanus wrightii* S. Watson
Populus prefremontii Dorf	*Populus fremontii* Watson
Prunus sp.	*Prunus andersonii* Gray
Pseudotsuga sp.	*Pseudotsuga macrocarpa* Mayr
Quercus lakevillensis Dorf	*Quercus agrifolia* Née.
Salix coalingensis Dorf	*Salix lasiolepis* Bentham
Sapindus sp.	*Sapindus* sp. (*S. drummondi* Hooker and Arnold?)

Six types of habitats appear to be represented by the vegetation now known from the Eden beds. Remains of monocotyledonous leaves are abundant in the collection and have been referred to *Gramineae* sp. The presence of grasses during the Eden epoch is corroborated by the occurrence in these beds of such grazing mammals as *Pliohippus* and *Pliauchenia*. The grasses probably occurred as a savannah rather than as a true grassland.

Several walnut fruits in the collection are closely similar to those of *Juglans californica* which today grows along the stream bottoms of the savannah and lower chaparral in southern California. Here it is commonly associated with *Salix lasiolepis*, *Platanus racemosa*, and *Populus fremontii*, all of which are represented in the Eden flora by the closely related fossil species *Salix coalingensis*, *Platanus paucidentata*, and *Populus prefremontii*. Several complete seeds of *Prunus* have their closest living equivalent in *P. andersonii*, whose present distribution is on the arid slopes and canyons of the desert ranges leading into the desert proper.

[1]1933. Op. cit., p. 517, footnote.

Platanus sp. (cf. *P. wrightii*) and *Sapindus* sp. (cf. *S. drummondi*), which are represented in the material by several leaves and a seed respectively, constitute a desert element which is no longer found in California. *Platanus wrightii* occurs in Arizona, New Mexico, and southward into Sonora, replacing *Platanus racemosa* in the desert stream courses; this latter species shows no tendency to follow desert drainage lines into the desert proper. On the basis of one seed it was not possible to determine the modern equivalent of the *Sapindus* sp., but according to the present distribution of this genus and the general ecologic conditions indicated by the flora, *S. drummondi* Hooker and Arnold is its probable living equivalent. In this desert habitat it is associated with *Platanus wrightii* and *Populus fremontii*, this latter form often extending down into the desert from its savannah riparian habitat.

Arctostaphylos, *Ceanothus* and *Cercocarpus*, all represented by leaves in the flora, are characteristic genera of the chaparral throughout southern California. A number of well-preserved leaves of *Quercus lakevillensis* are present; its living equivalent *Q. agrifolia* is abundant in the chaparral on the cooler northern slopes.

Pinus pieperi is represented in the material by a number of complete cones and seeds. *Pinus sabiniana*, its modern descendant, now grows in the hot dry valleys and foothills surrounding the Great Valley of California, where it is commonly associated with *Quercus douglasii* Hooker and Arnold. A fragment of a leaf possibly referable to this species is in the material. At present *Pinus sabiniana* has its southernmost locality about 120 miles north of Beaumont in the Sierra Liebre Mountains, from here extending for about 500 miles into southern Shasta and Trinity counties.

Pinus coulteri is found today along the upper reaches of the chaparral, occasionally associated with the upper Digger Pine forest (*Pinus sabiniana*), extending from the coast and cross-ranges of southern California into Lower California. This pine is represented in the fossil flora by a cone with a number of well-exposed seeds. A number of cones are definitely referable to *Pseudotsuga macrocarpa*, which occurs on the upper limits of the chaparral in cool canyons and on north slopes throughout the mountains of southern and Lower California.

The general picture suggested by this composite flora is of a low-lying desert basin into which material was transported from several plant formations occurring on the adjacent mountain slopes. Growing along the drainage lines of the desert proper were *Platanus* (cf. *P. wrightii*), *Populus*, and *Sapindus*, while *Prunus* probably extended down the can-

yons of the arid desert slopes. Above this association a savannah of oaks and grasses existed, giving way on its upper edges to an open forest of *Pinus pieperi*. A chaparral cover of *Arctostaphylos*, *Ceanothus*, and *Cercocarpus* occurred scattered through and above this forest. Among the typical riparian elements, *Populus*, *Salix*, *Platanus paucidentata*, and *Juglans* ranged through the savannah and well up into the lower chaparral. *Pinus* (cf. *coulteri*) was present on the upper edges of the Digger Pine forest and chaparral; *Pseudotsuga* (cf. *macrocarpa*) was confined to the moister canyons and north slopes above this *Pinus* and chaparral belt.

Such an assemblage, with the exception of *Platanus wrightii*, *Sapindus* sp. and *Pinus sabiniana*, is today found down the eastern slope of the San Jacinto Mountains about 30 miles east of the fossil locality. A similar flora is likewise present approximately 60 miles east of Beaumont, on the slopes of the San Bernardino Mountains, facing the Colorado Desert.

The Eden flora is related to the Orinda and Etchegoin floras as described by Dorf,[1] which are located 360 and 220 miles north of Beaumont; like them it contains a high percentage of chaparral and riparian elements, indicating a semi-arid interior, stream-bank habitat. As already stated, Frick considers the Eden mammalian fauna as of an Uppermost Pliocene age. A comparison of the Eden flora with other California Pliocene floras indicates an age not older than Middle Pliocene.

The occurrence of a desert element comprising *Platanus* (cf. *P. wrightii*) and *Sapindus* is consistent with the southern occurrence of this fossil flora, and is indicative of more arid conditions during the Pliocene than exist at the fossil locality today. *Sapindus* and *Platanus* reach their best development in the desert under a rainfall of 5 to 10 inches annually, while the chaparral now growing at Beaumont exists under a rainfall of approximately 20 inches. Since the Pliocene there has been a return to more mesophytic conditions, a trend which is in agreement with the evidence presented by other California floras of this age.[2] With increased rainfall in the late Pliocene and Pleistocene, the desert elements probably retreated southward along available lines of migration, since these species are no longer found in California.

[1]Dorf, E. 1933. 'Pliocene Floras of California.' Contrib. to Paleontology, Carnegie Inst. Wash., Pub. No. 412, p. 25.
[2]Dorf, op. cit., p. 66.